AGRICULTURE IN SURINAME.

(*See page* 31.)

[Figures 1, 5, 6, 9, 11, 12, 13 and 14 by Curiel, Paramaribo, figures 7, 8 and 10 by the courtesy of Prof. G. Stahel, figures 2, 3 and 4 by the author.]

FIG. 1.—*Cacao plantation.*

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FIG. 2.—*Liberian coffee plantation.*

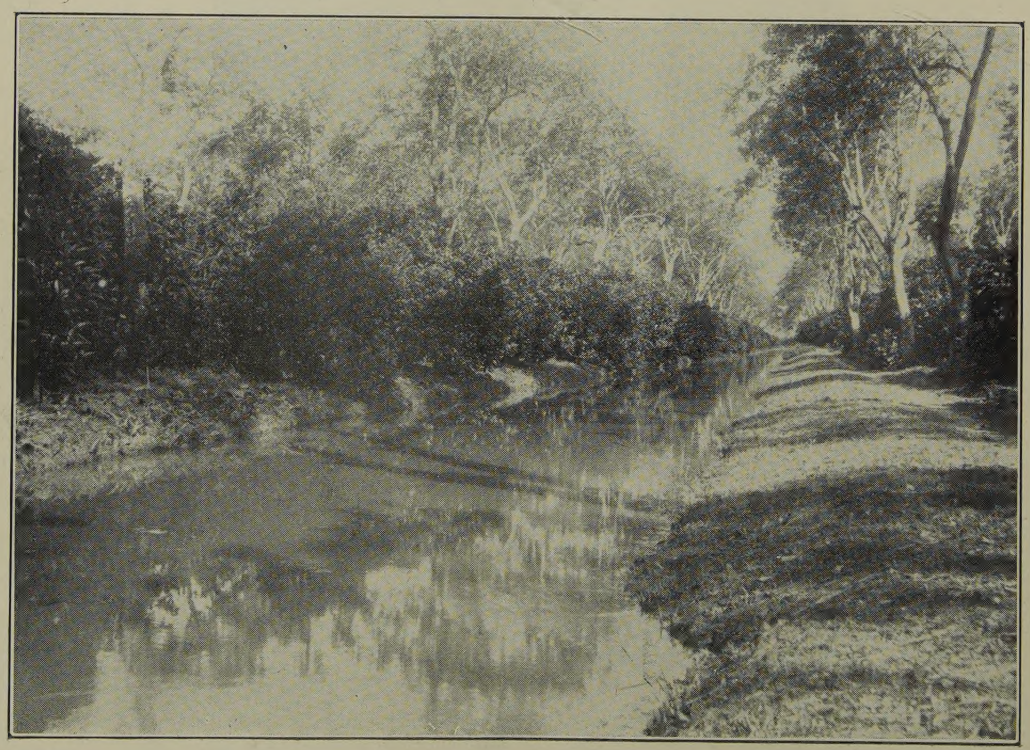

FIG. 3.—*Liberian coffee plantation.*

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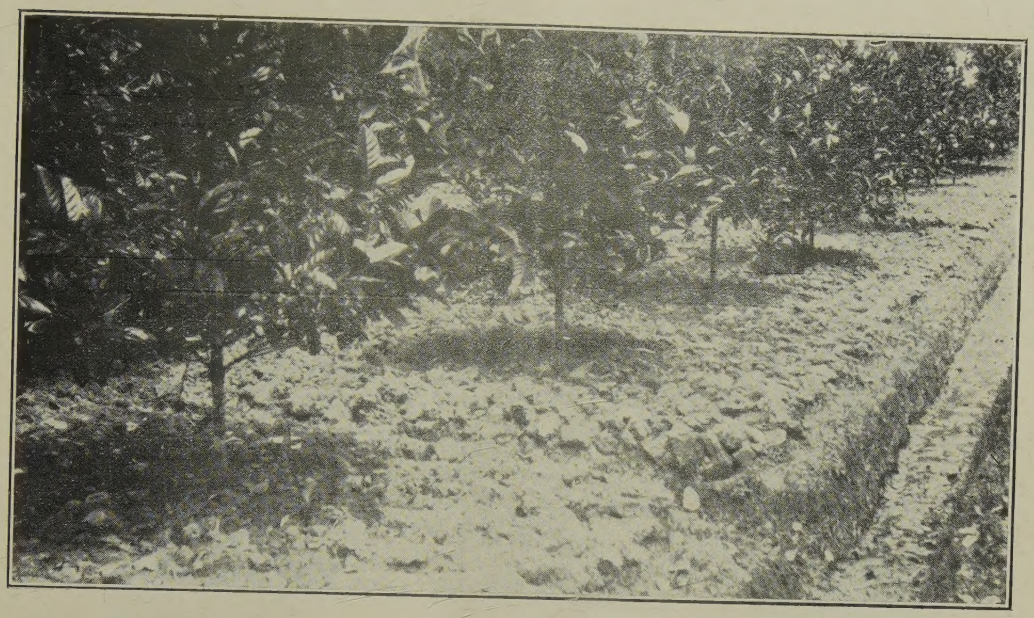

FIG. 4.—*Type of upkeep on good Liberian coffee plantation. Young plants.*

FIG. 5.—*Liberian coffee in heavy bearing.*

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FIG. 6.—*Cycle track through plantation.*

FIG. 7.—*Entrance to the savannah experiment station at Zandrerej. Right shows native cultivation and remains of bush; left, cassava plots of the experiment station.*

extensively. The native cotton and cacao crops had also been expanded to plantation scale. Thes then were the crops for which the estates along the Suriname and Commewijne rivers were opened up in the days of cheap labour. Table III gives some production figures for sugar and Table IV for coffee.

TABLE III.

EXPORT OF SUGAR FROM 1715.

Year.	*Metric tons.*
1715	9766
1765	10062
1805	5862
1825	11908
1875	10393
1895	8152
1900	10142
1905	8405
1910	9818

TABLE IV.

COFFEE: (ARABICA) GROWN SINCE 1721.

Year.	*Pounds.*
1721	50
1730	437
1735	503667
1760	1376335
1790	10206487
1810	14856275
1845	6504596
1885	1708479
1890	19946

To appreciate the present condition of agriculture on the coastal lands it is necessary to go back to the year 1895. Cacao, then a flourishing crop, was the most valuable product of the colony, with an output of 87,530 cwts for the year.

About that time witch-broom disease was reported in the Saramacca district where it was causing a considerable amount of damage. It spread throughout this area by degrees and was next noticed on the lower banks of the Commewijne and Suriname rivers. By 1902 the effects of the disease were seriously felt in the colony while in 1904 the damage done was so great that planters were faced with ruin. In 1905 and 1906 estates lying on the upper reaches of these rivers were also seriously affected. Table V gives some idea of the extent of crop reduction.

TABLE V.

AVERAGE CROPS FOR 5-YEAR PERIODS.

Years.	*Cwts.*
1893-1897	68,660
1898-1902	59,500
1903-1907	30,650

By 1905 the situation had become so acute that planters began to look for an alternative crop. Thus the inauguration of a banana industry resulted directly from the incidence of witch-broom disease. The decision to establish a banana industry was put into action in 1906 when an agreement was reached between the Suriname Government and the United Fruit Company. The contract provided that the Government should sell to the Company all merchantable bananas produced for export, and that 1,000 hectares or 2,470 acres of land should be planted before the first day of April of the years 1907, 1908 and 1909. Estimates were, of course, based on Jamaican and Central American production, and it was expected that these plantings would provide one and a half million bunches of bananas per annum, or a minimum shipment of 20,000 stems per week. The Suriname planters had not reckoned, however, on the relatively low output of fruit from their estates or on the incidence of Panama Disease.

As indicated by Table VI the estimated production was never approached, and few ships ever carried their minimum contracted cargo of 20,000 stems.

TABLE VI.

BANANA PRODUCTION FROM 1908-1913.

Year.	9-hand.	8-hand.	7-hand.	Total.	Per cent. Count Bunches.
1908	113,008	70,995	35,660	219,663	83
1909	381,178	176,001	91,475	648,636	86
1910	293,689	205,699	152,705	652,0 9	80.4
1911	172,250	118,457	93,390	384,097	79.8
1912-13	33,711	69,371	108,633	211,715	—

Panama Disease first appeared in 1906, plantations were seriously affected in 1908 and by the end of 1910, 1,200 hectares of a total of 3,300 hectares were infected. Congo bananas were planted in 1910 and during 1912 and 1913 some bunches were shipped. The industry, however, virtually concluded by the end of 1911, leaving both Government and planters in a sorry position.

The incidence of Panama Disease in Suriname was thus of unprecedented intensity. While no small interest attaches to a reconsideration of the facts in the light of modern pathology space does not permit of this at the present time.

(*c*) *The Establishment of Banana Plantations.*—In Suriname, in contrast to Central America, bananas were planted on estates that had already been established, and only occasionally was true virgin land employed. Some of the areas utilised had at one time been sugar estates, abandoned many years ago into pasturage or bush—"ruinate"—while others were cacao or coffee plantations whose production was on the decline. The worst of these were chopped down and planted with bananas. All the estates were empoldered and situated on the Suriname and Commewijne rivers.

The banana plantations were established under the supervision of the United Fruit Company, more or less according to Central American procedure, *i.e.*, a system of three foot drains was instituted and cultivation was carried out on an extensive system with the minimum amount of detailed treatment. As a matter of fact, however, more work was necessary in Suriname. The land was first cleared, burnt and forked to a depth of ten inches, whereas

in Central America the felled forest as a rule is allowed to decay *in situ*, while secondary bush is mainly overcome by the rapid growth of the young banana plants. In Suriname five or six brushings were required during the first year, and thereafter four or five brushings and one soil forking per annum. In Central America no forking is done and one or two brushings per annum suffice. In spite of the more elaborate cultivation practised in Suriname, production per acre was only 40 per cent. of that of Central American plantations. These observations, then, indicate that the clay soils of the alluvial belt, although of high potential fertility, are, relative to the requirements of the Gros Michel banana, by no means comparable to the natural soils of Central America. In 1910 and 1911 the Congo banana was planted and also *Erythrina* (the Immortelle or shade tree of cacao and coffee) and Liberian coffee. In 1912 the contract with the Fruit Company finished and by 1914 many of the fields were planted with Liberian coffee. Planting of the latter has gone on apace and at the present time it is the main agricultural crop.

(*d*) *The Present State of Agriculture.*—Having traced the history of the banana industry, we may now consider how the Dutch planter is attempting to cope with his agricultural problems.

With the decline of the banana industry in 1911 and 1912 planters began to establish young Liberian coffee plants using the remaining bananas (Gros Michel and Congo) for shade. *Erythrina* was also established as a shade tree so that a few years after the completion of the banana contract, coffee and cacao plantations were the order of the day. By this time "witch-broom" had been reinvestigated by Prof. Stahel, and it was found that it could be controlled at reasonable cost. The cacao industry, however, received its demise during the drought of 1925-26. On most plantations the old cacao trunks were then chopped out, the Immortelles were trimmed and Liberian coffee was planted. Thus where bananas and cacao once flourished Liberian coffee now reigns supreme, and the orderly appearance of plantations, the detailed tillage given to the soil, attention to plants, and upkeep of canals and walks, all testify to the tenacity of the Suriname planter and to the possibilities of his latest crop. Suriname estates like some in Trinidad have witnessed many agricultural experiments. One planter informed me that he had planted, at various times, sugar, rubber, sisal, cacao, coffee, cotton, bananas, cover crops and ground provisions. *Hevea* not only failed to grow well on the stiff clay but in 1915 was decimated by leaf disease; sisal proved unsuitable; cacao suffered from "witch-broom" and drought; bananas succumbed to Panama Disease; long staple cotton tried out some four years ago at Nickerie is now extinct on account of stainer. Liberian coffee alone remains as a staple product. So far only two diseases of importance have appeared, namely, phloem necrosis and *Sclerotium* disease. The former (which also includes die-back) so far has yielded no causative organism and is regarded as a physiological malady referable to the stiff badly aerated clay soils. The *Sclerotium* disease (*Sclerotium coffeicola*) affects the leaves and berries. It is common in some districts and is most important in seasons when the rainfall is high.

Suriname, then, may justly be cited as a land of agricultural vicissitudes. An old map of the colony shows the Suriname and Commewijne districts laid out in numerous small estates, somewhere in the vicinity of 800 in all. These date back to the days of slavery when the land was empoldered for the cultivation of sugar-cane, coffee (arabica), short staple cotton and cacao. The small estates have gradually declined and been abandoned or combined to form larger plantations. Now there are but 60 or 70 active plantations all told, including four under sugar-cane and two under coconuts. The day of the small plantation is past and larger properties formed by combining several of the original smaller holdings under one management alone can compete in the modern economic struggle.

(*e*) *The Liberian Coffee Plantation.*—The modern Suriname coffee estate provides an exceedingly pleasant spectacle. The plantation, of perhaps 1,000 acres, is amply provided with water-ways large and small, for drainage, navigation (transport), and sometimes for irrigation. These channels are excellent pieces of work and could only have been excavated in the days of cheap labour. The cost of such work is now prohibitive and only minor extensions are possible. Along the banks of these canals are well kept smooth path-ways on which a hard surface has been obtained by scattering gravel or shells. This upkeep is to facilitate cycling, the universal mode of travel in Suriname.

On these intractable clay soils Liberian coffee planting was an experiment with a risk. It has proved surprisingly successful. The trees, with a striking dark rank green foliage, grow strongly, and come into bearing in the third year and bear heavily in the fifth. They are topped high, 12 feet at least, and ladders are necessary for collecting the berries. In a land where labour is scarce the plant possesses many natural advantages. There is no definite seasonal fruiting, and flowers and berries in all stages of maturity are to be seen on the same tree. A further advantage lies in the fact that the berries hang on the branches for a considerable time after ripening. Production varies from two and a half to six bags per acre. Very good fields planted on pegassey areas may even yield seven bags per acre. These exceptional areas are, however, limited in extent. As for cacao the Immortelle (*Erythrina*) is used for supplying partial shade. On good properties the coffee trees are carefully pruned, the amount of overhead shade is regulated by lopping off branches of the *Erythrina* and the soil is forked once per year with careful upkeep of drains. In the early days of Liberian

coffee many of the young trees failed to grow well. Experience showed that this was directly referable to the stiff compact condition of the clays, and by assiduous forking even the poorest fields have been improved almost out of recognition. It would appear, then, that after many unrewarded efforts the Suriname planter has at last found in Liberian coffee a plant highly suited to his soils and labour conditions and with good marketing prospects.

The estates are mainly worked by British Indians and Javanese, introduced into the colony under the indenture system. The Suriname planter is divided in his opinion as to the merits of the two peoples. The British Indian is regarded as being able to get through more work, but tends to be irregular and troublesome. The Javanese are not quite so active but being of a very peaceable disposition and given to spending or getting rid of their pay almost at once, they are on the whole more dependable for regular work. Further, when they are induced to stay in the colony at the end of their contract they make good and diligent small-holders.

The day of the small planter is past, and estate owners realise that only large properties can be made to pay. Accordingly estates are being enlarged, mainly by the process of taking in abandoned land whose canals were dug in the old days of cheap labour. Under existing economic conditions it would be impossible to dig all the dykes and canals necessary for the establishment of a coastal plantation. On the plantations Berlyn and Maestrom on the northern bank of the Commewijne river the writer was able to make some interesting observations on such reclaimed land. The latter, lying between the plantation and the sea, had been used for coffee and sugar in the early days of the colony, and had been abandoned and flooded 100 years ago. Typical aquatic vegetation consisting of species of *Nymphaea, Montrichardia* ferns and sedges had become established. Three years ago the area was reclaimed by empoldering and draining, and planted with *Erythrina* and Liberian coffee. The growth of both the *Erythrina* and coffee during this time was astonishing; the latter was coming into bearing and the former was of tree-like stature. The vigorous growth was due to the layer of vegetable debris (pegasse) accumulated during the 100-year period under marsh conditions. The writer was interested to observe how much vegetable material had accumulated during this time, and found on inspection that the pegasse layer varied in depth from 15 to 24 inches. The true soil below consisted of a greyish white stiff clay. In the course of a few years the superficial layer of pegasse will disappear but experience has shown that the Liberian coffee can also thrive on the underlying clay.

(*f*) *Small-Holdings and "Farms"*—After the completion of their contract many of the Javanese labourers are induced by various government bounties to settle in the colony and take up small-holdings. At various points in the vicinity of Paramaribo such settlements may be inspected. The Javanese small-holders have a large amount of self-respect, a sense of property and are highly industrious in their own interests. Their houses are cool, clean and prosperous and are not without a sense of individuality. Roofs are thatched and walls are of woven rush-mats. Cultivation includes, according to the nature of land, rice, cassava, bananas, plantains, cacao and coffee, and estate training is reflected in the careful brushing, pruning and forking frequently observed on small-holders' land.

A rather interesting and unusual feature in Dutch Guiana is the 'farm,' *i.e.*, a farm according to the European concept. These were established about 1840, presumably in relation to the abolition of slavery, by Dutch emigrants, who instead of owning slaves or employing native labour, endeavoured to work the land themselves. While the system was never a great success yet it has survived and to the present day such farms can still be observed, being occupied and worked by descendants of the original owners. The farm consists of grazing land and fenced-off cultivated fields. The latter, carrying bananas and plantains, give good fruit as they receive careful attention and farm-yard manure.

(*g*) *The Experiment Station.*—The scientific aspect of agriculture in Suriname is represented by an Experiment Station with its Director (Prof. G. Stahel) and Staff. At the present time the major activities (apart from the laboratories and technical offices) are concerned with the selection of rice varieties, breeding of coffee varieties and experimental work on cacao, There is also a large and interesting collection of citrus varieties. Young oil palms (*Eleis guyanensis*) are being reared and tried out on various soils, while cassava, an important native crop, is represented by a considerable collection of varieties. Many plants of botanical interest, brought down from the interior at various times, have been successfully established in the garden. Among these the writer was interested to see seedlings of the wild cacao and rosewood.

In the laboratories work is carried out on plant diseases, soil chemistry and general botany, while a technical side is being developed to improve the maturing of various crops, milling of rice, and so on.

IV—The Savannah Lands.

Inland of the alluvial clays but still constituting part of the coastal plain is the savannah country. Slightly elevated above the coastal belt this extensive area consists for the most part of infertile sandy soils supporting in their native state bush of a poor type. Here and there localised fertile clay deposits, generally associated with rivers and creeks, occur. Geologically the country is granitic, but this material has been so extensively weathered and leached in the process of time that nothing now remains but large tracts of residual quartz sand—the sandy savannah. Most of this area has hitherto been regarded as useless

for agricultural purposes, permanent or otherwise. It is left untouched even by the aboriginal Indians who generally choose the more fertile areas in the vicinity of the rivers.

The large rivers, which traverse the sandy savannah on their way from the hills to the sea, have at some time deposited on their banks quantities of silt and clay. The riverside alluvial deposits extending perhaps 500 metres into the adjacent sandy savannah are not of high fertility. A partial analysis of a soil at Carolina, some distance up the Suriname river, is shown in Table VII.

TABLE VII.

RIVERSIDE SOIL AT CAROLINA, SURINAME RIVER (VAN DIJK).

Soil.	Moisture per cent. of the air-dried soil.	pH.	Humus.	Loss on Ignition.	P_2O_5 sol. in 2 per cent. citr. acid.	Mg. equiv. CaO adsorbed 100 gms. of soil.	Clay 0.002 mm.
			Per cent. of the soil dried at 105°C.				
0-30 cm. ..	4.93	4.50	3.6	14.1	traces	1.7	49.2
30-60 cm. ..	6.37	4.70	0.5	13.0	traces	traces	61.1

The writer was able to inspect these riverside soils at Carolina and at the Jews' Savannah. While of good texture they are essentially poor and support in their natural state low bush. They are decidedly acid, have a low humus content, and contain only traces of phosphoric acid. Planted with cacao almost 150 years ago by persecuted Jews from Brazil they have never proved of high agricultural value, and as they are inextensive and distant from Paramaribo they have not attracted settlers. The adjacent sandy savannah carries a typical xerophytic scrub vegetation and is useless for any kind of agriculture.

As the savannah land constitutes a very considerable part of the colony and is easily accessible by the rivers which are tidal far into this region, it might be expected that some attempt would be made to exploit its agricultural resources. Those areas which consist entirely of coarse and fine quartz sand have, of course, to be ruled out. In the vicinity of rivers and creeks, however, as the result of local deposition of clay and silt, areas of greater fertility occur. Quite recently an interesting experiment has been commenced by Prof. Stahel on such an area at Zandrerej (Place of sand), some 43 kilometres from Paramaribo by rail. The land chosen is adjacent to a creek, and all gradations in soil composition from pure sand (on the savannah side) to heavy clay (by the creek) occur.

TABLE VIII.

ANALYSIS OF SOIL AND SUB-SOIL AT ZANDREREJ (VAN DIJK).

Soil of Cassava plot at Zandrerej.	Moisture per cent. of the air-dried soil.	pH.	Humus.	Loss on Ignition.	P_2O_5 sol. in 2 per cent. citr. acid.	Mg. equiv. CaO adsorbed 100 gms. of soil.	Clay 0.002 mm.
			Per cent. of the soil dried at 105°C.				
0-30 cms. ..	2.54	4.60	2.7	7.1	traces	0.35	17.2
30-60 cms. ..	2.87	4.70	1.5	7.4	traces	traces	28.8
60-90 cms. ..	3.15	4.60	0.8	8.1	traces	0.24	33.1

Table VIII, gives a partial analysis of a sandy loam on which cassava has been established. The soil is acid and deficient in the essential minerals. Phosphoric acid, for example, is present only in traces.

Several experiments are in progress. On one plot, a light sandy loam, young oil palms have been established with various cover crops. The young palms appeared to be in a thriving condition. On a slightly heavier sandy loam various cassava and

maize manurial experiments were in progress. These soils are very highly leached and in their natural state contain very little food material. As their physical texture is good, however, they respond readily to fertilisers. This was clearly indicated by the marked differences between manured and unmanured plots. The question is whether or not it can be put on a paying basis. An area of the heavier land adjacent to the creek has been cleared and planted with Immortelle with a view to establishing cacao. Another similar area has already been planted with cacao hybrids and budded stock, *Tephrosia candida* being used for shade. The whole experimental area includes 10½ acres of oil palms, 3 acres of cassava and maize, and 36 acres for cacao. The labour gang, of Javanese, East Indians, Carib Indians and Negroes, required for the development of the experimental station is about 40 strong, but it is estimated that a gang of 20 will suffice for upkeep later on.

This experiment is probably the first of its kind to be carried out on the highly leached sandy savannahs of tropical South America. Its object is to explore the agricultural possibilities of these little known inland regions—an experiment whose result, be it positive or negative, cannot fail to be of very considerable value. Already it has been found that fertile savannah areas are very localised. The inference is that while they may be suited to small-holders or peasantry, they are not likely to attract the attention of companies operating on a large scale with a central uniform organisation. The latter is precluded by the fact that the soil composition virtually changes every few kilometres. The results of this experiment should not only prove of use to our own neighbouring colony of British Guiana in particular (where similar extensive sandy savannahs occur), but they should be assured a wider interest, as highly leached soils of this type are common throughout the tropics.

V.—The Hilly Interior.

As one proceeds further inland the savannah gradually merges into the hilly country of the interior—an extensive area of low weathered hills extending to the Brazilian frontier. Practically uninhabited and little known, this extensive area which constitutes by far the largest part of the colony, has few agricultural activities. Of these, logging and balata bleeding, carried out mainly by the Bush Negroes (the descendants of run-away slaves), alone are worthy of mention. The hills composed originally of igneous rock have been brought to a lateritic condition by extensive weathering. The soils are pebbly and fairly porous.

The fertility of hillside soils, though not great, is superior to that of the sandy savannah. For experimental purposes one area, 73 kilometres from Paramaribo by rail, has been cleared and planted with oil palms. The object is to determine if the rolling hilly country can be made to carry crops of economic value. The young palms appeared to be thriving on the porous lateritic soil. From the point of view of large-scale enterprise the great draw-back to this region lies in the fact that the areas suitable for planting are inextensive and broken up on account of the rolling nature of the country. So far no extensive agricultural project has been attempted in the hilly interior and experiment alone will show whether it has any qualities or crop-suitability likely to attract either the small planter or larger agricultural organisations. In the meantime the experimental work which has been commenced should supply valuable and interesting information.

VI. Concluding Remarks.

From these brief observations it will be seen that agriculture in Suriname is essentially identified with the coastal alluvial belt. The savannahs have only localised areas of intermediate fertility while crops have yet to be found suitable for the soils of the hilly country beyond. Again, recent explorations into the far interior did not reveal any large tracts of good land suited to extensive agriculture—the only type possible with the present population. It would thus appear that the Suriname planters by tackling and overcoming the many difficulties encountered on the coastal alluvium, have made the most of the colony's possibilities.

Much of the information contained in this article was collected during several excursions made in company with Prof. G. Stahel, Director of the Experiment Station, and Mr. J. W. Van Dijk, Agricultural Chemist, who kindly supplied the accompanying chemical data. The writer takes this opportunity of expressing his sincere thanks to both.

A SIMPLE IRRIGATION DEVICE.

A simple counterpoise waterlift, of the pattern that is seen all through the Tropics, where water can be attained for the irrigation of the peasants' crops, has recently been working at the pond near the Field Office (*see* photographs, p. xvi). The *Shadoof*, as this kind of lift is called in Egypt, has recently received some attention from Dr. J. S. Haldane and Dr. Gandell Henderson (*Nat.* 118, 308) who have shown that it is a remarkably efficient lift. It is simple and can easily be repaired with local materials. An interesting variation of this is the *Picottah*, which in Madras, is worked by two men, one of whom moves up and down on the beam itself and thus utilises his weight to swing it. His fellow meantime tips each bucket load to the accompaniment of a chant which combines the number of the tally with a selection of conventional blessings. When the tale is complete, the men change places. This not unmelodious sound is often heard at night, when the men frequently work; not however, without risk of broken limbs for a fall in such circumstances is not uncommon.

R. C. W.

RATIONALISATION.

Rationalisation with special reference to Tropical Agriculture.

By H. M. Leake, sc.d.

There are certain obvious similarities between tropical agriculture and industrial development which must strike every one. As with industry, the development of tropical areas has proceeded apace since the war with the consequent increased, and increasing, output of tropical produce. The development has, in most cases, led to overloaded markets. Sugar, rubber, cocoa, coffee, to mention only some of the products, have all passed through a period of depression of which the end is not in all cases in sight. Herein, again, lies a similarity with the industrial position of Britain. The past few years have seen a remarkable impetus given to the campaign for opening up the tropics and the motive power is the need for expanding markets for Britain's industrial output; the railway material, motor transport and so on required for such development. But it is frequently forgotten that these are poor countries and that these requirements can only be paid for if markets are found for the produce which is, in the main, agricultural. It would almost seem that this slogan of tropical development has arisen too late and that the immediate need is for consolidation of the position won rather than further expansion. Industries, too, in the face of increased capacity of output and reduced purchasing power have had to face the same problem, and it is from industrial experience gained in the hard school of depression through which it has passed that a pertinent lesson may be learned.

That lesson is summed up in the word rationalisation. This word, too, has become a slogan and is certainly open to abuse. It has been described by an unbeliever as the dictation to business men by financiers unacquainted with the details of the business they propose to subject to the process. And certainly it has its dangers; disregard of its limitations will lead to inevitable reaction. Nevertheless, rightly used within its limitations it appears to offer a solution, if not a permanent solution, for present economic ills and to offer a breathing space for the world to recover equilibrium after the shock of war.

Over-production seeks its remedy in two ways; it seeks fresh markets and it seeks to expand existing markets. The former it accomplishes by advertisement; the latter, not without compulsion and a strict limitation, by reducing price. A third, and less willingly adopted method is reduction of supply. The cause for this unwillingness lies firstly in the competition of independent competing units of production where each is for himself and the devil take the hindmost, and, secondly, in the fact that reduced output is incompatible with reduced price. Overhead charges do not bear a constant relation to output. It is these disabilities that rationalisation aims to circumvent and the outward and visible sign is the combination or merger.

Combination, adequately effected, has various beneficial effects. It should permit the establishment within the organisation of its own selling agencies thus realising to itself the agency, or middleman's profit; it should permit the modernisation of plant and, having its eye to the future, it should ensure that its methods are the most modern by employing technical advice which constitutes an overhead charge that it is, owing to its size, able to bear. These should ensure, and have as their aim the retention of low costs of production. Combination should with its added financial strength, convey a flexibility of supply which should bring this into closer accord with demand, with greater stability of prices as the consequence. This is the process which has come to be known as rationalisation. It is no simple process. Under one set of conditions importance will attach to one, under another set of conditions importance will attach to another, of the above aspects. Hence the complexity and hence the opening for confusion.

Tropical agriculture has been promoted under many systems. In the more densely populated tracts like India and West Africa, it is carried on as a small holding industry which, in as far as it produces for sale, is subject to the competition of more highly organised producers. Rarely can unorganised production on these lines compete with the more highly organised systems. Special circumstances have combined to make such production of rubber in the Dutch East Indies profitable, but the very real threat to the West African palm oil industry from the Dutch plantation product is more typical. The safeguard here is that specialisation has not progressed to any marked extent and the small producer remains self-supporting in the matter of essentials, including in these, food. In less densely populated tracts, as were the uplands of Ceylon and Assam and as are Malaya and the major part of Tropical Africa, the producer is an individual of alien origin or a company with strictly limited sphere of activity and as limited capital. Rarely, as in the Sudan, is there to be found a company in any way comparable to the large modern industrial organisation. Where the unit is an individual there is a field for co-operation in the disposal of produce for it is where production is for an export market that co-operation has secured its greatest successes. Where, however, the unit is a company there appears to be a rich field for rationalisation. In this field not only is rationalisation capable of achieving all the objects enumerated above but it is the only way in which that great source of weakness in tropical agriculture, dependence on a single crop, can in most cases be overcome. How great that weakness is under present conditions is shown by a comparison of the dividend returns of any Ceylon company having tea, rubber and perhaps coconuts, among its assets with those of a Malay rubber company whose sole interest is rubber.

It is along such lines that rationalisation could be applied with advantage to tropical production. The disadvantages pertain rather to its field in

industry. The first of its effects is a diminished demand for labour, a serious matter in a country like England where labour has no alternative field of employment but of small account where, as in most places in the tropics, the difficulty is rather one of securing an adequate labour force. A later, and more serious offset is the added importance of finance which may come to mask, as it has in America, the basic function of the supply of a rational market. The natural tendency, when the financial aspect assumes too great a predominance, is to force production and to create irrational markets. Concerned as tropical agriculture is mainly with the essential requirements of man and particularly with his food products, the danger is minimised. The human appetite for food is limited in a way its appetite for luxuries is not and an irrational market is not readily stimulated. The saturation point is sooner reached and more readily asserts its influence.

AGRICULTURE IN CEYLON.

In his administration Report for 1928, the Acting Director, Mr. W. Small, gives an outline of the work of the Department for that year, while detailed reports are included from the Curators of the various botanic gardens.

Work in connection with green manuring and the use of cover crops, has been continued. It has been shown that the maximum amount of nitrogen is acquired by the soil when the green crops are turned in while freshly cut, and that the greatest loss occurs where the material is allowed to wilt during periods of alternate dry and wet weather before being buried.

Further observations have been made in connection with the increased water-retaining capacity of the soil, due to green manuring. The rate of decomposition of green manure under anaerobic conditions, such as occur in paddy fields, has also been investigated.

A trial of *Indigofera endecaphylla* as a cover crop for Tea has been continued, and was fully reported in *The Tropical Agriculturist* of February, 1928. *Centrosema pubescens*, *Calapogonium mucunoides*, and Vigna, have been tested as cover crops in rubber, and an indigenous cover plant, *Dunbaria heyeni*, is under trial and showing promise.

The subject of soil erosion and its methods of prevention, have received considerable attention. Preventive measures at the time of clearing have proved successful, and the planting of cover crops, drainage, and contour terracing, are dealt with as methods of control.

Paddy selection work has been continued, and results have been satisfactory. Increased interest in the field trials and a desire to obtain seed of the successful selections, are being displayed by growers. Manurial trials on paddy have been undertaken in connection with both artificial fertilizers and green manures, and varieties of seed from Burma and California are undergoing trial.

In addition to the problems mentioned above, the following list includes some of the investigations which are being carried out at the various experimental stations.

Manurial trials on Tea.

Manurial trials on Rubber (Reported in the *Tropical Agriculturist* for July and November, 1928).

Rubber Tapping.

Fodder Grass trials (Bulletin 84).

Improvement of native-owned cocoa plantations.

Sugar-Cane Cultivation.

A new Experimental Station and Farm School are being established at Labuduwa. The building has been commenced and part of the land cleared and planted with fruit trees, rubber, tea, coffee, &c.

Nurseries in various parts of the country have been successful, and have provided a supply of economic and other plants for distribution.

Work in connection with the substitution of permanent cultivation for the older shifting system is continuing. It has been demonstrated that permanent cultivation is possible even though any change from the existing system must necessarily take place over a long period, and in connection with it, the necessity for weeding and mulching, addition of humus, and the value attendant upon implemental tillage, have been displayed. It is suggested that the granting of larger areas of land and some security of tenure, will be necessary for the success of this introduced system of permanent agriculture.

The season was unfavourable for cotton growing and in spite of the increase of 400 acres in the cotton area of the Southern Division, the crop (1.911¾ cwt.) was only 4 cwt. greater than in the previous year.

Lectures and demonstrations have been given by Agricultural Officers and Plant Pest Inspectors, and some educational literature has been published. Instruction is also available at the Farm Schools.

In addition to the advisory work of the mycological and entomological sections, the former has been engaged in investigating fungous diseases of paddy and coconut, and *Rhizoctonia bataticola*, in woody plants has received special attention. In the entomological division work has been done on the nettle grubs of tea, and experiments have been carried out in connection with the possible insect cause or carrier of bunchy-top disease of plantains. Attention has also been paid to the Eulophid parasite of the coconut caterpillar.

In the Chemistry Section, apart from advisory work and investigations into the use of manures, &c., the study of the leaching of fertilizers under local conditions has been continued.

D. B.

The Editor requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

LABOUR EFFICIENCY.

A preliminary statement on relativity of factors adversely affecting the efficiency of agricultural labourers.

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Introduction.

THE following is a preliminary account of work at the Imperial College of Tropical Agriculture on the important subject of labour efficiency in Trinidad. The collection of data was started some years ago during an investigation of the dietetic aspect of nephritis and infantile mortality, but it was supplemented by data on the feeding of indigenous rats on standard native diets and unbalanced dietetic articles such as various roots and tubers. In 1928-29 a systematic examination of estate labourers was commenced. A special form was used with each separate article of diet tabulated, so that the exact amount consumed, cost and deductions could be entered against it. Detailed records were kept of each labourer and his or her fortnightly food budget and also of any garden produce they had. A detailed medical examination was made and the records entered. The figures cover between seven and eight hundred individuals from 20 estates.

Important medical aspects are involved in a survey of labour efficiency. These include a consideration of (1) Diet, (2) Health, (3) Fatigue and willingness to work, (4) Psychological aspects.

From an analysis of the various medical statistics collected the following general statements have been set forth. The observations comprise diets of East and West Indian labourers on sugar and cacao estates separately, and also the extent of disease incidence among them. An investigation on this subject is important for various reasons.

(1) The efficiency of labour and its bearing on production costs. (Average work, half a week only.)
(2) Correlation of diet and disease.
(3) Various aspects of specific articles of diet, harmful, unsuitable, or consumed in too small amounts.

The question of imported *versus* local foods.

(4) The consideration of encouraging the production of suitable local foods.

(1) Diet.

The staple diet consists of :

(1) Rice (brown rice, parboiled and milled but not polished).
(2) White flour.
(3) Irish potatoes and local root crops.
(4) Salt fish.
(5) Sugar.
(6) Pulses (Peas and Beans).

While the supplementary diet includes meat, milk, vegetable oil, bananas, mangoes, sugar-cane, fats and eggs—it should be stated that many of the latter group are only used occasionally and in very small quantities.

East Indian dietary shows a superiority in some respects over West Indian, and likewise sugar estates show consistently better dietetic statistics than cacao estates. The morbidity percentages show a parallel deviation with the diet figures. On one particular estate where there were special facilities for procuring meat and milk the health condition was very much better, but these figures are not given separately in this paper.

The main articles of diet, rice, white flour, salt fish and Irish potatoes are all imported. The rice comes mostly from the East as it is preferred owing to its lower price, but it is not always a well conditioned rice from the point of view of dietetic value. Salt fish ,of course, has poor nutritive value whilst Irish potatoes are not as good as some of the roots and tubers that can be grown locally. There is a great tendency to buy things in a tin or carton but these foods which have been sterilised and preserved by superheating or by drying have lost a considerable amount of their nutritive value. The milk used is mostly imported tinned milk—a partially defective food. On the average an unnecessary amount is spent on tobacco, cigarettes, rum and stout—even by the East Indians. The East Indian eats less rice than in India but makes it up by eating white flour which is not so good as the "atta" of India. Furthermore they eat too little in the way of pulses and here again prefer to buy the imported dhal rather than eat the locally grown peas and beans which contain a good percentage of vegetable protein of a fair biological value. The proteins consumed are mostly of a poor tissue repairing power, *i.e.*, of low biological protein value. Ghee (clarified butter) is expensive and they eat far too little animal fat, replacing it by a certain amount of coconut oil. The deficiency of protein and fat, particularly animal fat, is a salient feature.

See Figs. 1, 2 and 3.

Diet requirements.

A labourer doing muscular work should have a diet containing at least 120 grammes of protein and anything up to 100 grammes of fat, and a goodly percentage of both of these should be of animal as well as of vegetable origin. These amounts with a backing of about 500 grammes of carbohydrate with a good vitamin and mineral salt content should produce from 4,000 to 5,000 calories per individual per diem which is about the heat energy and tissue repair standard required, but on reference to the graphs and figures given it will be seen that the actual diets fall very short of this desideratum.

Their diet contains altogether too much starch and sugar, too little animal or vegetable protein and is highly deficient in fat, especially of animal

FIG. I. COMPOSITION IN GRAMMES OF INDIVIDUAL DAILY DIET

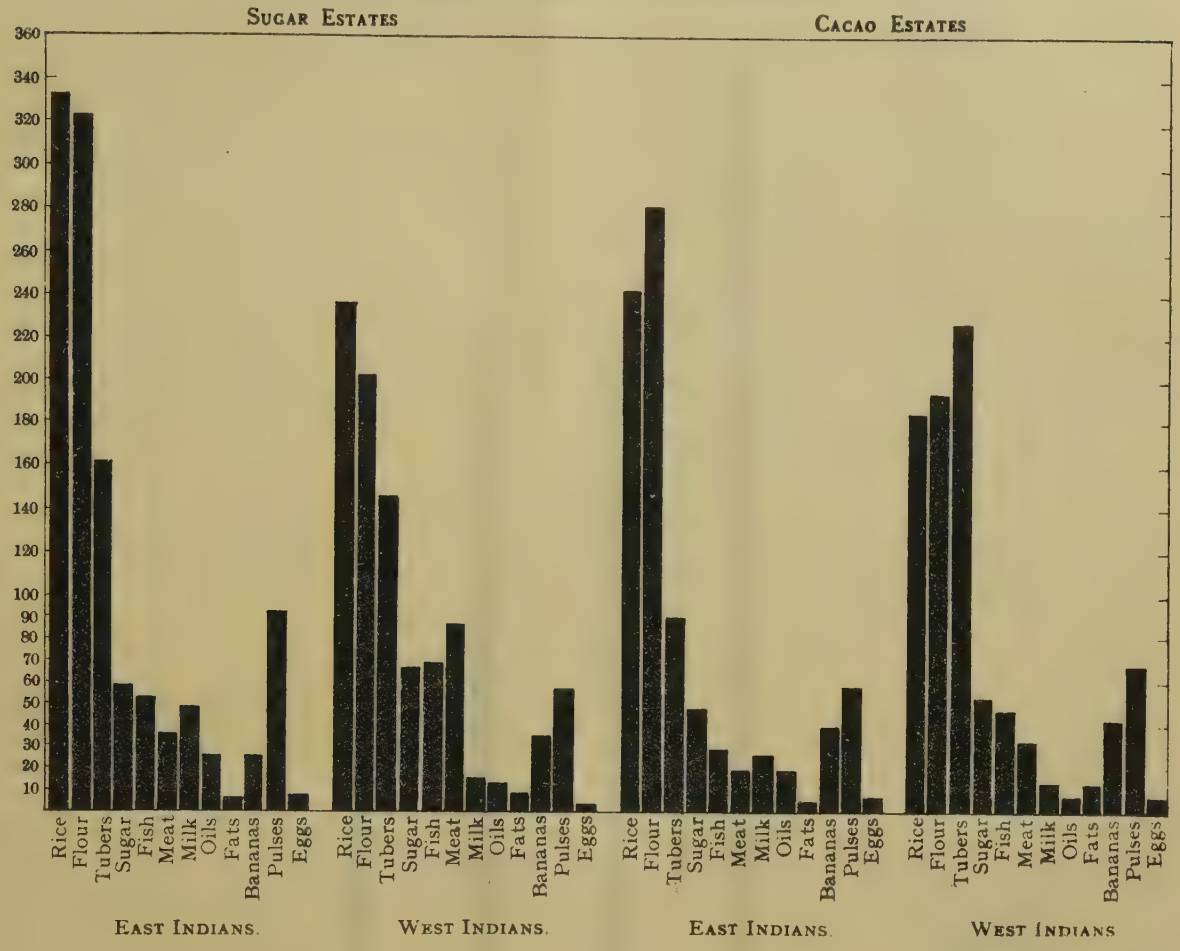
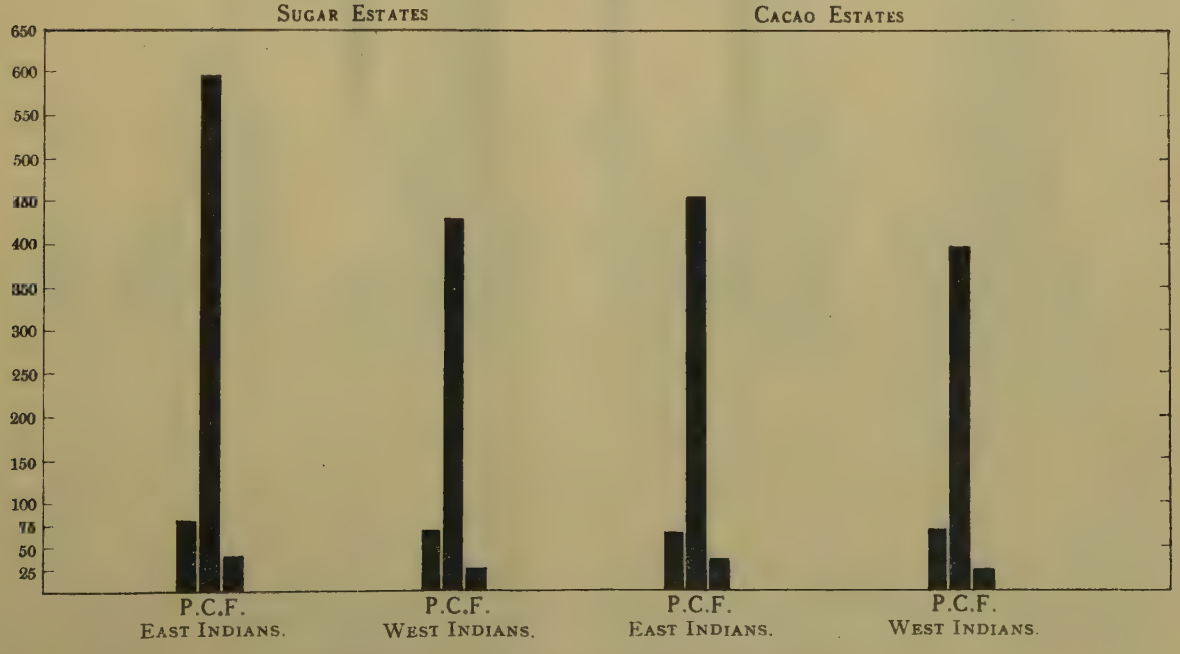
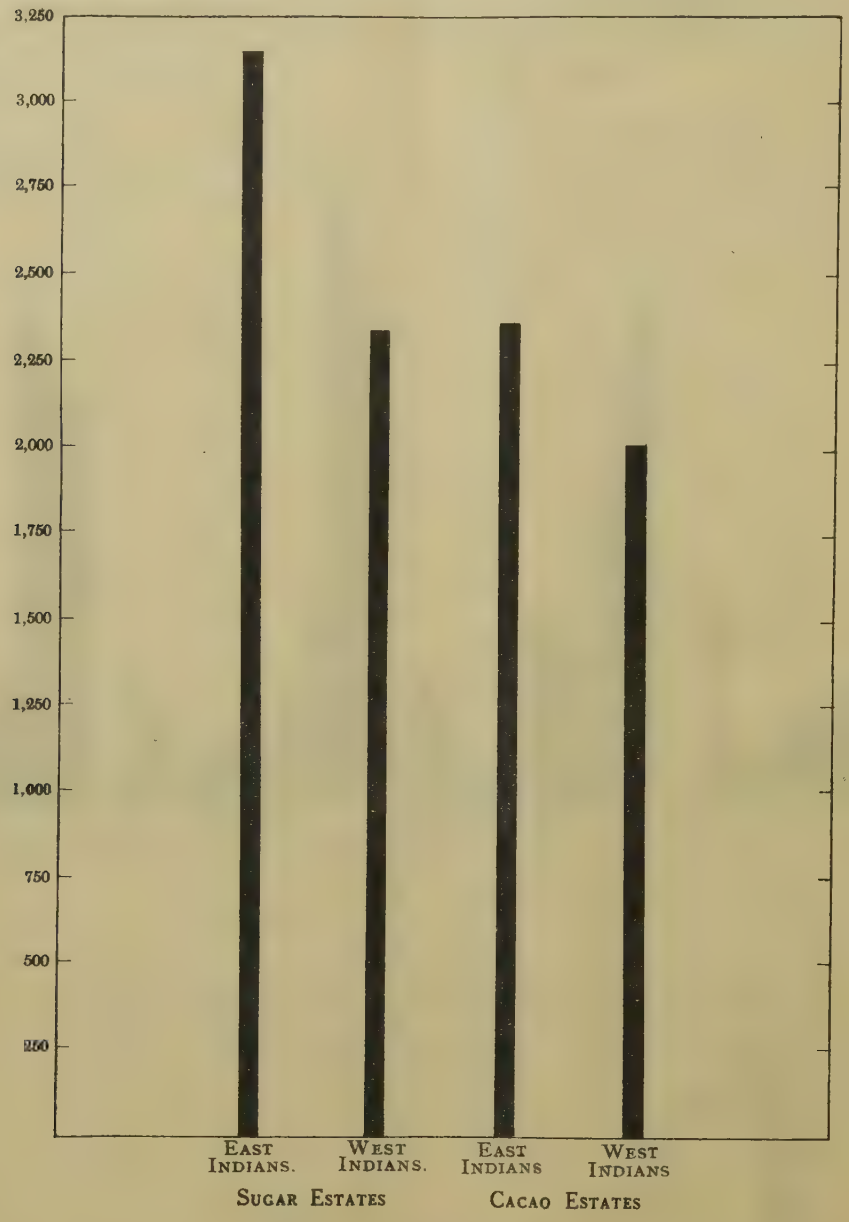


FIG. II. PERCENTAGE COMPOSITION OF INDIVIDUAL DAILY DIET



GRAMMES OF PROTEINS, CARBOHYDRATES, FATS

FIG. III. CALORIC VALUE OF INDIVIDUAL DAILY DIET



origin. In such a diet there is a vitamin deficiency and it remains to be seen if the mineral salt content is satisfactory. The only immediate remedy for such a condition lies in the encouragement of workers to produce or buy home grown cereals and pulses, and to increase the keeping of fowls and cows or goats. Margarine of vegetable origin would not solve the fat deficiency.

(2) Health.

A very large percentage of labourers over thirty showed marked heart and blood vessel deterioration, which is so marked by forty as to handicap them seriously and shorten their expectation of life. This condition is more marked in West Indians than in East Indians and bears a definite relationship to faulty diet as well as to toxic factors as will be seen from the graphs and the tables.

The percentage incidences of the various diseases afflicting agricultural labourers represent the minimum assessment and consist only of those showing obvious clinical manifestations. For instance the hookworm percentage stands solely for those showing well marked signs and not by microscopic test for ova in the faeces. Only those with lesions of syphilis actually present are put down and not by Wasserman reaction of the blood. The latter would undoubtedly yield a much higher figure. Again those marked as suffering from

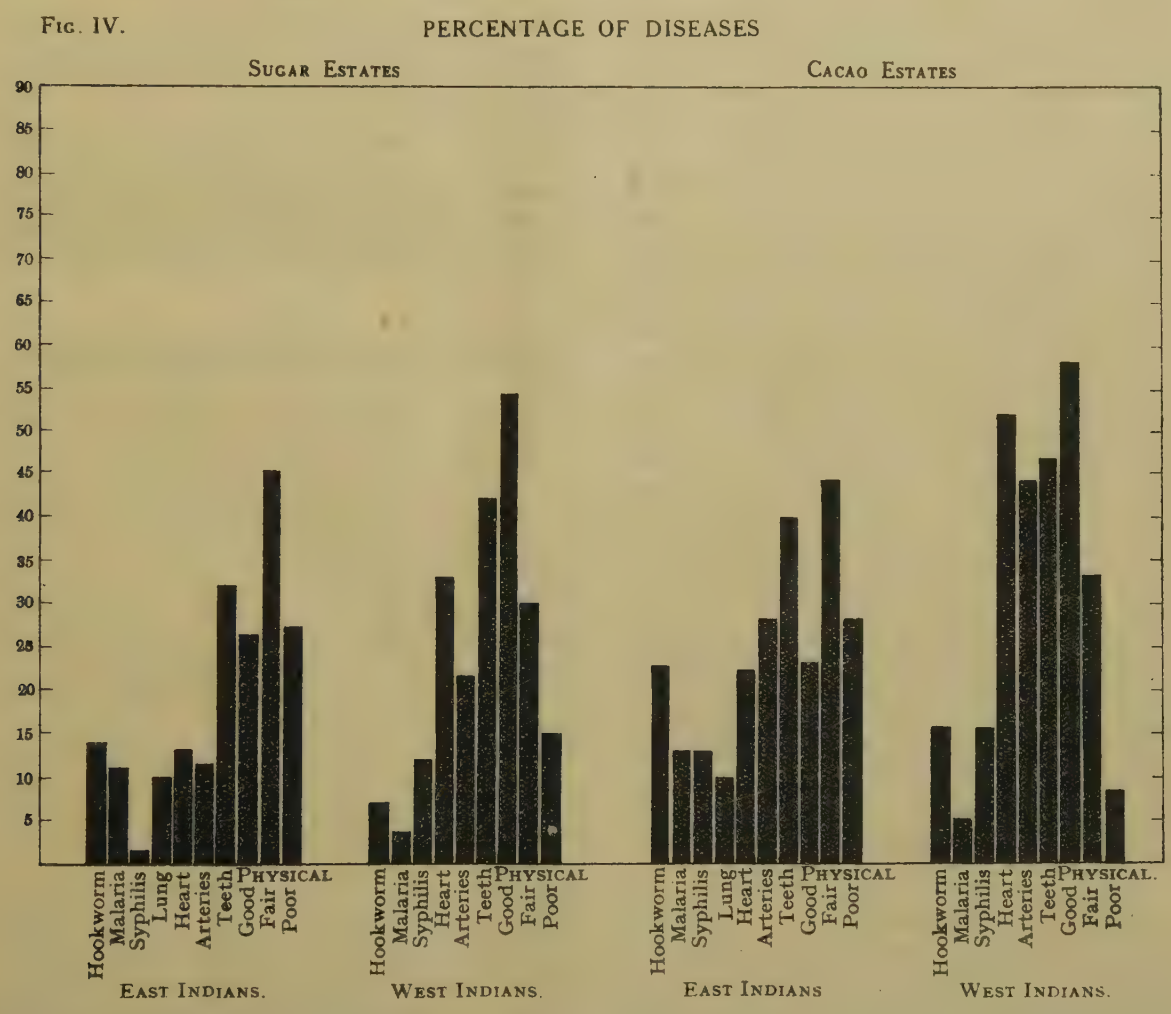
malaria are confined to those with enlarged spleens. The Nephritis (Kidney disease) incidence which is high is not given as this subject is being investigated in special detail by bio-chemical tests, but from work on rats it does not appear to have any reference to the consumption of any one specific article such as tannia or other tubers in a reasonably balanced diet. Nephritis would appear to be an excellent hygienic index of a community as it indicates toxic soakage or defective diet. The cardio-vascular degeneration which is so serious a feature belongs to this group and these figures are given in tables IV and V and Figure IV. East Indians suffer considerably from bronchial asthma which appears in their case to be largely a Vitamin A deficiency as the exhibition of animal fats and protein such as cod liver oil and milk clears it up.

There are grounds for the belief that a portion of the conjunctival affections in East Indians may be due to Vitamin A deficiency also. Some of the variations in disease susceptibility between East and West Indians can only be explained on a basic assumption of hereditary tissue tendencies, but apart from predisposition, partial inanition seems to be the exciting or precipitating factor.

There are certain groups of intestinal disease that appear to bear a relationship to diet—possibly Vitamin A and B deficiency—and these are being further investigated.

The large percentage of teeth defectiveness is due to faulty calcium and phosphorous ingestion and metabolism in adolescence combined with the eating of soft foods containing too much starch and sugar which adhere between the teeth and undergo fermentative decomposition with acid formation which etches the enamel and so starts decay.

FIG. IV.



(3) Fatigue and Willingness to Work.

The factors that determine the output of work by agricultural labourers are extremely complex. Their physical handicaps arising from poisoning by disease, and the lessened energy, stamina, and resistance to the invasion of disease arising as sequelae of inanition due to deficient and defective diet, certainly directly lowers their fatigue curve and indirectly diminishes their mental urge to work. Climatic factors have a bearing also, heat, humidity, and the rainy seasons. The instinctive conservation of energy that varies in tropical races is a factor of some importance also—it is, however, a factor that is rather difficult to assess. It may

be stated as a rough generalisation that the agricultural labourer actually works on the field for an average of five hours a day but he only works on four days out of the seven per week, making a general average of twenty working hours per week. Even allowing fully for the physical subtraction it cannot possibly be admitted that he reaches fatigue point with such an output, consequently early in the investigation the analysis of the psychological aspect was kept in mind, and held over until the material side had been examined.

(4) Psychological Aspects.

The difficulties of the psychological examination are very great because it is not always easy to gauge the true mental attitude of an individual labourer towards his work. The mental processes and customs of the natives have to be studied to see how far it is a question of only working until they acquire a sum on which they can subsist, and how far the condition has been brought about by employers themselves by altering the ratio of task to the wage rate.

The responsibility of the employer both from the point of view of the fitness of the worker and his potentiality for work, is an exceedingly comprehensive problem and while it is felt that important results might be sought from this aspect a definitive opinion cannot at present be offered.

There is evidence that much can be done to increase the efficiency of labour apart altogether from wage increase, not only on the material side of sanitation and treatment, but more by education in better habits of living and concerning articles of food that would be better eliminated or substituted. The greatest need, however, is for suitable educative measures that can be calculated gradually to change the attitude of the agricultural labourer concerning his methods and hours of working and his consequent wage earning in relation to his fortnightly household budget. Changed market conditions have called for radical alteration in production methods and while this has been rapidly promoted as regards the factory side everything connected with the field labourer remains the same as it did under the old regime. A suggestion of this kind is of course submitted tentatively as wide inferences are involved—these include the willingness of the East Indian to depart from deeply ingrained family and racial customs and his changed psychological disposition if such habits and customs were abandoned.

Summary.

1. This preliminary article deals with the question of labour efficiency in Trinidad from the medical aspect, especially with reference to diet, health, fatigue and willingness to work and the correlated psychology.

2. An account is given of the articles of diet, together with a discussion of their respective values. Briefly they consist of a surplus of carbohydrates and a deficiency of fats, proteins, and vitamins. Explanatory graphs are submitted.

3. Under health, the percentage incidence of diseases are set forth. Correlations between health and diet are drawn.

4. With regard to Fatigue and willingness to work, while the physical aspect is important the psychological is also of very great importance.

5. A tentative discussion of ways and means to improve the existing conditions is given.

Acknowledgment.

The writer's thanks are due to Professor C. Y. Shephard of the Department of Economics for making arrangements with the estates and for general discussions of the problem. I have further to thank him, together with Captain J. M. Wingate and Mr. T. R. Hayes for assistance in filling up the diet sheets.

Appendix.

Some of the data on which the foregoing observations and figures are based are submitted in the accompanying tables for those who might wish a more detailed analysis.

The caloric values were worked out both from Kilo caloric values of each foodstuff and from the Protein, Carbohydrate, and Fat composition. As these data are mainly for comparative purposes the latter has been adopted as the standard.

TABLE I.

Composition of individual daily diet in Grammes.

Items.	Sugar Estates.		Cacao Estates.	
	East Indians.	West Indians.	East Indians.	West Indians.
Rice ..	332	236	241	184
Flour ..	324	203	281	194
Tubers ..	161	137	90	229
Sugar ..	58	66	49	53
Fish ..	52	68	29	48
Meat ..	36	85	19	33
Milk ..	49	16	24	12
Oils ..	24	13	19	6
Fats ..	6	9	2	12
Bananas ..	23	36	41	42
Peas & Beans	93	58	58	68
Eggs ..	4	2	3	3
Total Grms.	1,162	929	856	884

TABLE II.

PERCENTAGE COMPOSITION OF INDIVIDUAL DAILY DIET IN GRAMMES.

Sugar Estates.

Items.	East Indians.			West Indians.		
	Proteins.	Carbo-hydrates.	Fats.	Proteins.	Carbo-hydrates.	Fats.
Rice	16	249	1	11	177	—
Flour	27	195	8	17	120	4
Tubers	2	36	.8	2	27	.68
Sugar	—	58	—	—	66	—
Fish	5	—	—	7	—	—
Meat	6	—	—	17	—	—
Milk	2.7	2.8	2.7	.57	.7	.57
Oils	—	—	24	—	—	13
Fats	—	—	6	—	—	9
Bananas	—	5	—	.54	7	—
Peas and Beans	23	46	2	15	29	5.8
Eggs	2	—	—	1	—	—
Total Grammes	83.7	591.8	44.5	71.11	426.7	33.05
	Total Calories = 3183.4			*Total Calories* = 2348.386		

TABLE III.

PERCENTAGE COMPOSITION OF INDIVIDUAL DAILY DIET IN GRAMMES.

Cacao Estates.

Items.	East Indians.			West Indians.		
	Proteins.	Carbo-hydrates.	Fats.	Proteins.	Carbo-hydrates.	Fats.
Rice	12	180	—	9	138	.7
Flour	23	168	5	18	114	4
Tubers	1.44	18	.5	4.6	46	1
Sugar	—	49	—	—	53	—
Fish	3	—	—	5	—	—
Meat	4	—	—	6	—	—
Milk	.86	1	.86	.4	.6	.4
Oils	—	—	19	—	—	6
Fats	—	—	2	—	—	12
Bananas	.6	8	—	.63	8	—
Peas and Beans	14	29	1	17	34	1
Eggs	1.5	—	—	1.5	—	—
Total Grammes	60.4	453	28.36	62.13	393.6	25.1
	Total Calories = 2368.688			*Total Calories* = 2101.923.		

TABLE IV.

Sugar Estates.

PERCENTAGE OF DISEASES.

Diseases	*East Indians.* %	*Diseases.*	*West Indians.* %
Hookworm ..	14	Hookworm ..	7
Malaria ..	11	Malaria ..	3
Syphilis ..	1	Syphilis ..	12
Lung ..	**10**	Lung ..	**0**
Heart ..	**13**	Heart ..	**33**
Arteries ..	**11**	Arteries ..	**21**
Teeth (Defective)	32	Teeth (Defective)	42
Physical condition :		Physical condition :	
Good ..	26	Good ..	54
Fair ..	45	Fair ..	30
Poor ..	29	Poor ..	16

TABLE V.

Cacao Estates.

PERCENTAGE OF DISEASES.

Diseases.	*East Indians.* %	*Diseases.*	*West Indians.* %
Hookworm ..	23	Hookworm ..	16
Malaria ..	13	Malaria ..	5
Syphilis ..	13	Syphilis ..	16
Lung ..	**10**	Lung ..	**0**
Heart ..	**22**	Heart ..	**52**
Arteries ..	**28**	Arteries ..	**44**
Teeth (Defective) :	40	Teeth (Defective)	47
Physical condition :		Physical condition :	
Good ..	23	Good ..	58
Fair ..	47	Fair ..	33
Poor ..	30	Poor ..	9

SUGAR CONFERENCE.

II. Factory Information.

[*Published below are summaries of the more important papers, containing Cane factory data, that were read at the Third Conference, held at Sourabaya, Java, of the International Society of Sugar-Cane Technologists.*]

Preparation of Cane and Grooving.—W. L. McCLEERY. *Bulletin No.* 18.

A paper describing Hawaiian practice in the use of Knives, Shredders, Crushers and Grooving.

Knives.—Revolving Cane Knives have been in use in Hawaii for many years. At the present time all but six of 39 factories use knives. Of those 33 factories, 25 use one set of knives, and eight factories two sets. When one set is used it is always placed at the upper end of the carrier. The introduction of knives has brought about a gradual change from wooden carrier slats to overlapping steel slats. All factories using knives are now equipped with the latter.

The tendency in recent years has been to locate the upper knives slightly beyond the head of the carrier, with the tips about in line with the carrier slats. The knives spread the cane as it comes over the end of the carrier, and the first milling unit is kept equally filled from one side to the other. In non-shredder factories the distance between knives is 2½ inches or less, and the tips clear the slats as closely as possible. In shredder factories usually only one set of knives is used, the distance between knives varies from 2½ inches to seven inches and the clearance is from 15 inches to 18 inches.

The optimum speed is about 500 r.p.m. When lower knives are used, they are installed near the bottom of the cane carrier and used as levellers; the speed is from 400 to 600 r.p.m.; clearance 14 inches to 18 inches and distance between knives one inch to six inches.

Although the power consumption under ordinary conditions is rather less than one horse-power per ton of cane per hour, new installations are based on a power requirement of 1.5 H.P. per ton cane per hour in order to allow for peak loads and dull knives.

Knives are in favour in Hawaii for their aid in obtaining increased capacity due to better feeding characteristics of the partially cut cane, practical elimination of chokes, and even loading of mills across their full width. In non-shredder factories, mill extraction is favoured through evener feed and better absorption of maceration at an earlier stage.

Shredders.—National Shredders have all been discarded in favour of Searby Shredders. Eleven factories use the latter which in all cases but one is preceded by a crusher. Tests of Searby Shredders installed after a two-roller crusher have indicated an increased capacity up to 20 per cent. without lowering the extraction; or if the same rate of grinding is maintained, one could expect an increase in extraction of 2.5, 1.25 or 0.8 per cent. respectively with nine, 12 or 15 roller tandems.

Many of the Searby Shredders were formerly driven by steam turbines; but owing to the high steam consumption of the units employed, those have all been replaced by motors. Motor sizes are calculated at 3.75 H.P. per ton cane per hour, although tests on power requirement show a normal power consumption of about 2 H.P. per ton cane per hour. Power consumption can be unnecessarily increased by 30 to 40 per cent. if too many angular bars are used or if the clearance is too small. Six bars in addition to the anvil bar, set with ⅛ inch clearance at the top, and ¾ inch clearance at the bottom should combine satisfactory quality of work with economy of power.

There has been no work done with the Maxwell Shredder in Hawaii but results in Java are understood to be most encouraging.

Crushers.—All but two Hawaiian factories employ crushers, 22 factories using the Krajewski type, six the Fulton-type, while nine have three-roller crushers. Krajewski rollers are cast steel and last longer; but Fulton-type rollers can be made from discarded mill rollers. Fulton-type rollers give better drainage of juice and somewhat higher extraction. Some Krajewski installations have juice grooves in lower rollers to improve drainage and capacity. Two-roller crushers have a higher surface speed than the first mill. 25 per cent. in the case of the Fulton and 50 per cent. with the Krajewski type. Two-roller crushers to feed well can carry only 40 to 50 tons hydraulic pressure per foot-length of roller as compared with 60 to 80 tons in the succeeding units. Higher speeds and lower pressures appear necessary for capacity and prevention of chokes. Three-roller crushers which are really coarse-grooved three-roller mills are doing very good work in Hawaii. The grooving is about 60° and 1½ inches pitch. The grooves are set meshing with openings of ⅝ inch and $\frac{1}{16}$ inch. Hydraulic pressure is from 75 to 80 tons per foot length of roller and the surface speed about the same as for the succeeding mills or 21 feet per minute. Those crushers are usually preceded by at least one set of closely set knives, and will give an extraction of 72 to 78 per cent. of the juice as compared with 40 to 50 per cent. for a two-roller crusher.

Grooving—Grooving practice varies greatly in Hawaii owing to varying conditions at the different factories. Many factories have standardized their grooving for their own conditions; and it may be stated that the grooving is always the finest that can get the desired amount of cane into the mills to the point where pressure can be applied. Except in three-roller crusher installation, ¾ inch grooving of about 60° angle is used in feed rollers up to the third and fourth mills; while grooving in top and discharge rollers varies from ⅜ inch to six or seven grooves to the inch. In some instances the ¾ inch spacing is used in all first-mill rollers as well as in feed rollers of all succeeding units.

The three-roller crusher grooving is usually 1½ inches pitch with from four to seven grooves per inch in all succeeding units.

Messchaert grooves invented in Hawaii about 1913 were first used on feed rollers to increase capacity, but it was found that with the resulting closer setting extraction was also increased. Later it was found that those grooves cut in the discharge rollers reduced the moisture in bagasse. They are now cut in all bottom rollers, spaced from two to three inches, and are from 1½ inches to two inches deep. They should be at least 1¼ inches deep to ensure drainage. The width enlarges with wear, but ¼ inch in feed rollers and ⅛ inch in discharge rollers is sufficient to ensure drainage. The grooves must be kept clean; two, and sometimes three, sets of scrapers are used on discharge rollers. Juice grooves have increased capacity from 15 to 20 per cent. increased extraction up to two per cent. and reduced moisture in final bagasse about five per cent.

W. S.

* * *

A Study on Milling and on Hot Maceration of the Bagasse—Dr. V. Khainovsky. *Bulletin No.* 16.

This bulletin sums up the investigations carried out at the Java Sugar Experiment Station on the behaviour of bagasse during the milling and maceration process, which have led to a new system of milling control, as well as to the application of a new method of hot maceration. One of the essential points of those investigations was the determination of the volume of bagasse which in turn involved methods for the determination of the volumes of air, juice and fibre in bagasse.

Although the presence of air in bagasse is detrimental to proper admixture of added water with juice left in the broken cells during the milling process, it plays an important part in the determination of the volume of fibre and of juice left in bagasse. Those determinations are effected by the pneumatic extraction of bagasse, which is carried out as follows:—A certain quantity of bagasse is placed in a closed container and covered with known volumes of water and oil. The total volume of the mixture is equal to the volume of water, oil air-containing bagasse. The vessel is placed under vacuum when a large portion of the air expands and escapes through the supernatant liquids. On returning the vessel to atmospheric pressure the total volume of mixture will be less than before, the difference corresponding to the escaped air. A certain volume of air still remains in the bagasse which is determined as follows:—The vessel is placed once more under vacuum and the expansion in volume noted. This expansion corresponds to the increase in volume of air between the two known pressures, and its volume at atmospheric pressure is calculated therefrom. If we subtract the volume of remaining air and volumes of water and oil from the total volume, we obtain the volume of air-free bagasse. Since the volume of juice in bagasse can be calculated from the analysis of the bagasse the volume of fibre is obtained by subtraction. Once the volume of a given weight of bagasse is known, it is possible to calculate the volume of bagasse passing per unit of unrolled volume in a mill.

The presence of air in bagasse is further utilized in determining the amount of sugar and therefore of juice, in the broken cells by extraction with cold water. A certain weight of bagasse is placed in a closed vessel and covered with a known quantity of cold water. The vessel is alternately brought under vacuum and atmospheric pressure from 15 to 20 times. The pulsating effect caused by repeated expansion and contraction of the air contained in the bagasse causes thorough mixing of the juice left in the broken cells with the water. This amount of juice is calculated from the polarization. The mixture is then boiled in the usual manner for an hour. The difference between the total polarization and the polarization of the cold extract corresponds to the sugar contained in the living or unbroken cells. A relationship is thus established between the proportion of sugar contained in the broken cells and in the living cells of bagasse issuing from a given mill. When the results are expressed per 100 fibre, comparable figures are obtained for the individual mills of a mill-train, and the data can be expressed graphically. Numerous graphs are given in the bulletin illustrating the practical application of this method of control, and showing the separate effects of maceration and pressure.

Those investigations have naturally led to the replacement of cold by hot maceration since the living cells in the bagasse are not accessible to cold maceration. The presence of air in the bagasse makes it impossible to obtain proper admixture of the macerating liquid with the juice in the bagasse by ordinary methods of imbibition and in the time usually allowed. Hot maceration in Java is therefore now applied by means of special equipment between the mills in which the bagasse undergoes an intensive lixiviation with hot water or juice. The most efficient method, as well as the best constructed apparatus for the purpose seems, at the present time, to be provided by the Nobel Macerating, Carrier. In this carrier which is almost closed and which travels at a rate several times slower than the ordinary carrier, the thick layer of bagasse is treated several times with hot maceration liquids in counter current. The more and more concentrated juice is reheated between each application, and is finally applied to the bagasse entering the preceding mill. A feeding roll is necessary to get rid of the excess water with bagasse so treated; and the setting of the mill must be different to the setting employed with cold maceration. A notable reduction of both moisture and polarization in bagasse issuing from the mill after such treatment has been observed. A serious drawback of the Nobel system of maceration is its extensive use of steam which has amounted in experiments conducted by the Experiment Station to 10 per cent. of the total steam consumption of the factory.

W. S

A Comparative Study of Milling as practised in Cuba, Hawaii and Java. FRANCIS MAXWELL. *Bulletin No.* 20.

The salient features characterizing modern milling in the three leading cane sugar countries may be epitomized thus:—

Cuba implies large capacities with relatively long trains and big units; Hawaii moderate capacities with high extraction, short trains and thorough preparation; Java is somewhere in between. Cuban centrals tend towards trains of six mills (five at least) preceded by single or double crushers, a common size of mills being 36 inches by 84 inches. In the Hawaiian Islands the majority of factories are equipped with a standard plant consisting of a crusher and four mills. The size of mills chiefly met with in Hawaii are 34 inches by 78 inches and 32 inches by 66 inches; in Java 30 inches by 60 inches and 32 inches by 72 inches.

Apart from capacities the essential difference in principle between Cuba and Hawaii lies in the question of cane preparation. Generally speaking Cuba relies for the proper disintegration of the cane upon the aggregate "grinding" effect of her multiple crushers supported by deep-grooved first and second mills. In Hawaii the preparation of the cane is confined to, and thoroughly performed by, knives and shredders co-operating with single crushers. The fineness of bagasse ente ing the first mill in Hawaii is often equal to that entering the third or fourth mill in Cuba; and therefore all mills of the train in the former case serve practically entirely as pressing or extracting units.

Mill engineers seem to be in fundamental agreement that it is necessary to extract as much juice as possible in the earliest stages in order that maceration should be more efficient and complete. In the Hawaiian Islands the art of cane preparation has attained a high level of development and is chiefly responsible for the uncommonly high extraction obtaining there.

Knives.—About 80 per cent. of mills in Hawaii are provided with one or two sets of revolving knives. Where two sets of knives are used the first set levels the cane, and the second cuts and prepares it. In recent years on account of power required and juice squeezed out, there has been a general tendency towards less heavy preparation by knives.

In Cuba cane knives have only recently come into vogue while in Java only two or three of the 179 factories use knives.

Both in Cuba and Hawaii where cane is fairly short and is mechanically unloaded on to the carrier, a thorough tangled mass of fairly great depth ascends the carrier which must undergo some kind of preparation prior to entering the first unit of the milling train in order to obtain capacity. In such cases rational application of revolving knives will increase capacity 10 to 15 per cent.

In Java, on the other hand, the cane is long and straight, and is laid in even parallel layers on the carrier. Cane knives in this case cannot show to the best advantage.

It appears that the economic utility of cane knives is confined to feeding purposes. Cane preparation in the true sense of the word is the function of the shredder, usually in conjunction with a crusher.

Shredders.—The advantages of a modern shredder are:—

(1) Thorough disintegration of the cane into fine shreds.
(2) The evening up of feed to the mills.
(3) Saving in power in the following mills.

Java affords a convenient opportunity of comparing two adjacent factories one with and the other without a shredder. The bagasse from the first mill in the former case is practically as disintegrated as the bagasse leaving the last mill of the latter. Shredders add to both capacity and extraction. With excessively long trains of mills the economical importance of the shredder would be the possibility of discarding one, or perhaps two mills.

Crushers.—The basic difference in this respect is that Cuba uses multiple crushers, whereas in Hawaii and Java single crushers form the standard practice. Results of investigations in Java on the merits of multiple crushers were unfavourable to their adoption; and the author had previously stated that "multiple crushers have no economic reason for existence."

In Java the Krajewski type of crusher is universally met with since the method of feeding canes in parallel layers does not encourage the use of Fulton-type rollers or the Hawaiian three-roller crusher. In some factories a "figured" or "toothed" crusher roll is substituted for the top roller of the first mill. This adaptation fits admirably the methods of feeding obtaining there.

In Hawaii both the Krajewski and the splitting type of crushers are used, but the tendency is towards three-roller crushers with intermeshing 60° grooves of 1½ inches to 1¼ inches pitch.

Grooving.—The adoption of deep grooves in the mill rollers in Cuba has contributed a considerable share in the large capacities obtained. Common practice in Cuba is to groove rollers of all mills ½ inch pitch throughout, except those of the first mill which are usually 1 inch pitch. When dealing with very large capacities the first and second mills are often grooved 1½ inches and 1 inch pitch respectively or even deeper. The angle of the grooves is usually 55°.

The standard practice of grooving in Hawaii may be taken to be as follows:—First mill—all three rollers ¾ inch pitch with grooves intermeshing; other mills—front roller ¾ inch pitch, top and back rollers 7 grooves to the inch; the angle of the grooves being 55 to 60°.

In Java the standard practice remains, shallow grooving or practically smooth rollers, Java being apparently alone among important cane sugar countries in adhering to shallow grooving. Feeding devices to a certain extent overcome difficulties attendant upon increased capacity. It has been noticed in Natal and elsewhere that the advantages derived from deep grooving are appreciably greater when crushing hard and fibrous canes such as "Uba."

Briefly the prime factors contributing to an increase in capacity and extraction by applying deep grooves are:—

(*a*) Increase of aggregate gripping surface of the rollers.

(*b*) Facilitated drainage of the juice.

(*c*) Tearing action afforded by the differential speed between apex and base of the grooves.

Messchaert Grooves.—Although Messchaert grooves serve solely to promote drainage of juice, they were originally conceived by their inventor as a feeding device. They enhance capacity besides increasing extraction and yielding a drier bagasse.

In the Hawaiian Islands the use of Messchaert grooves is universal. All lower rollers (except some first mill front rollers) are provided with those grooves. Pitch 3 inches, but preferably 2 inches if possible; depth $1\frac{1}{4}$ inches, preferably $1\frac{3}{4}$ inches; width $\frac{1}{4}$ inch to $\frac{5}{16}$ inch.

The use of Messchaert grooves is extending in Cuba; but the bulk of opinion is still unfavourable to those grooves in Java.

The full benefit of Messchaert-grooving is not experienced until cane is efficiently disintegrated, and sufficient imbibition water is applied. When better preparation of cane and intensified maceration are more largely practised in Java it can be predicted that drainage grooves will also become general practice.

Maceration.—The common practice of imbibition in Cuba, Hawaii, Java and elsewhere, is to pour the liquid in sheet-form (juice) or spraying-form (water) on to the surface of the bagasse blanket. This method is a most primitive and inefficient one since by judicious application of maceration or lixiviation a considerable proportion of the sucrose in bagasse can be extracted more economically by other means than by brute pressure. The system of "hot maceration" after Nobel which has been recently introduced in several Java factories appears to have given good results. It is evident that with this and other similar methods, a certain degree of disintegration of the cane is necessary to secure maximum efficiency. There is no reason why in a fourteen-roller plant, which includes a shredder there should not be three such "maceration carriers"; in which case maximum extraction could be obtained with a few mills without reduction of capacity.

In Egypt a train of four milling units combined with the Naudet diffusion process is actually achieving superior results to the longest of milling trains in use elsewhere; coupled with the considerable advantage of abolishing all settling tanks and filter-presses.

Summarizing, the writer considers that a modern milling plant need only consist of a crusher and four mills supplemented by a shredder, roller feeding devices, and a system of "hot maceration" (Nobel); the rollers of the mills being provided with deep-grooving and Messchaert grooves. Scientific examination of the factors involved show conclusively that persuasive rather than forceful means should be applied to induce the juice to leave its cellular abode. Persuasive means include combing of the canes into fine shreds followed by washing out of the sugar thereform by means of intense maceration, lixiviation or preferably diffusion, aided by successive or final pressings without the use of unnecessary force.

W. S.

(*To be continued.*)

THE PINK BOLLWORM.

The use of the Aeroplane for tracking the Pest of the American Cotton Field.

[*The following article by Mr. John A. Todd, is reproduced from the "Commercial," Vol. XIX, No.* 488.]

PINK BOLLWORM enjoys the distinction, among all the pests that cotton is heir to, of being the most widespread throughout the world. It is now known in virtually every cotton-growing country, and for the last ten or twelve years has caused a good deal of anxiety in the United States by its sporadic appearance in various parts of the the western belt. The first recorded outbreak was in Texas in 1917, when two groups of countries were affected—(1) a group of six, four in Eastern Texas and two across the border in Louisiana; (2) five points in Western Texas and New Mexico, all near the Mexican border. The first group was supposed to have originated from a cargo of cotton seed which had suffered shipwreck on the coast of Texas, but the second group could not be traced to any specific cause, and was supposed vaguely to have come somehow from Mexico, where the pest has been well known for a much longer time.

As the result of very drastic measures adopted by the Government the outbreak in Eastern Texas and Louisiana was apparently got completely under control, no trace of the pest being discovered there after 1921. But in the western valleys of the Rio Grande and Pecos rivers it has never been found possible to eradicate the pest completely, and small sporadic outbreaks have been reported almost every year. It was hoped, however, that the isolated position of these districts, and the fact that there was a

belt of perhaps 200 miles of no cotton country between them and the main Texas belt, would reduce the danger of the worm spreading into the latter to negligible proportions.

Since 1921 there have been frequent new outbreaks of the worm in these western parts of Texas, and early in 1927 there were really alarming reports that the insect had spread into the western fringes of the main Texas belt. Fortunately, however, stringent measures were at once taken, and these seem to have been effective, for there has been no word since of any general spread of the trouble.

In the meantime, however, both the Federal Government authorities and those of the State of Texas have been carrying out a great deal of scientific inquiry into the habits of the pest, its methods of propagation, and especially its means of travelling from one area to another, and these have now produced some very interesting results, which may prove to be of the greatest value to every other cotton-growing country where the pink bollworm has been a serious menace. The most interesting of all is what really amounts to a discovery as to the probable means of locomotion of the pest.

The investigators were puzzled by the fact that in these western areas the outbreak always seemed to be more of the nature of a new infestation than of the continued presence of the pest carried over from year to year. This, and possibly a hint from some earlier work, suggested to Dr. B. R. Coad, of the Government Bureau of Entomology, at Tallulah, La., a line of investigation which has proved extremely fruitful.

In connection with his work, which covers the whole belt, Dr. Coad has frequently to make very long journeys, and for these he uses some of the Government aeroplanes which have been employed for several years in dusting cotton fields for boll weevil. It occurred to him to make some experiments on what might be called the entomological content of the upper air. He devised a small "bug-trap," which he carries on his aeroplane and records the captures made at various altitudes, and the first results of this work were to produce definite evidence of the pink bollworm moth flying at high altitudes, up to about 3,000 feet. Following up this clue, the scientists proceeded to trace the movements of the pest, first through aeroplane flights and second by putting down trap plots of cotton in districts far remote from any existing cotton field. To make a long story short, the result is that they have worked out an almost complete chain of circumstantial evidence, from which they have been able to build up an entirely credible theory of the whole nature of the problem. It appears that the prime source of infestation is probably in the Laguna Valley in Mexico, where pink bollworm is always present in considerable numbers throughout the whole season.

The first step was to study the habits of the moth at home in this district, and the striking fact emerged that while the moth shows no inclination to stray from home throughout the summer, a period comes about the beginning of September when it suddenly develops a desire to migrate. This was detected by the erection of screens over the fields, and throughout the summer no moths were caught on these screens; but about 1st September they suddenly began to rise in large numbers. Then the aeroplanes came into the investigation, and they were able to trace the movements of the moth all the way from Mexico across two hundred miles of desert to the nearest outlying points of the cotton belt, which lie in the Big Bend district of the Rio Grande, thence to the isolated irrigated districts in the Pecos Valley, and thence to the western fringes of the main cotton belt in Texas itself.

It appears that the moths are carried up involuntarily by strong convection currents to a maximum of about 3,000 feet. There they meet a prevailing "contra-trade" wind blowing from south to north, which is apparently persistent and entirely independent of the currents of air lower down. By this they are carried northward till, somewhere north of the United States boundary, they meet a kind of wall of contrary winds which checks their progress so that large numbers of them fall to the ground alive. In this way their presence was detected in the trap plots laid out into the desert from the western fringe of the cotton belt, and most of those, which had been quite clear of the pest till about 1st September, were very soon found to be infested after that date.

Not for a long time has so fascinating a theory been found to fit so exactly the facts of the situation, and the most satisfactory feature of the whole thing is that it clearly indicates the line of attack. Existing measures for tackling the pest when it arrives in the western belt, must, of course, be continued, but the main object of attack must be the centre of infection in Mexico itself. It is understood that measures with that end in view are under consideration, though the problem presents what is probably quite a new feature in international relations.

JAVAN TERMITES.

In an article which appears in the Hawaiian Planters' Record, Vol. XXXIII, No. 4, Mr. R. H. Van Zwaluwenburg states that the termite species of the Netherlands East Indies appear to be primarily pests of certain agricultural crops, notably of teak and of *Hevea* rubber, rather than of buildings and wooden structures. Several natural enemies of termites, most of them predators, and only three true parasites, occur in the Malay Archipelago, but none of them is sufficiently effective to warrant introduction into Hawaii where the termite problem is primarily an urban one, while such termite enemies as are present in Java are adapted to forest conditions.

TROPICAL WORLD NOTES.

Nyasaland.

According to a Report by the Hon. Imperial Trade Correspondent at Limbe, both the external and internal trade of Nyasaland during 1928 was affected by the depression in the market for Empire tobacco, but with less serious results than anticipated. This reflects very favourably on the country's resources. If compared with the trade of the last normal year, 1926, the trade of Nyasaland not only continues to hold its own but to make gratifying progress. The uncertainty of the tobacco market restricted the production of this crop, only 5,193 tons being exported in 1928 as against 6,904 tons in 1927; of this, however, only 17 per cent. of the 1927 quantity was stripped tobacco while the proportion of strips shipped in 1928 was 36.2 per cent. On a *pro rata* percentage basis the 1928 total would have been 5,476 tons. Of the shipment weights 28.8 per cent. was native produced tobacco as against 43.47 in 1927.

The stabilised and improved prices guaranteed for cotton at the time the seed was issued induced natives to take a keener interest in this crop, and with good climatic conditions there was a considerably larger production than during the preceding year. Natives produced over 90 per cent. of the year's crop.

The improved tea export figures indicate the increasing interest being taken in the production of this commodity. Although the shipment weight at the end of the year reached 637 tons, an increase over 1927 of 114 tons, the acreages now under cultivation promise that in a year or two this weight will be at least doubled.

The other of the four principal productions of the Protectorate—sisal—has taken second place in weight of exports, having reached the record total of 1,161½ tons.

* * *

Kenya.

The question of forming a Coffee Institute was recently discussed at a meeting of Coffee Planters in Nairobi, and a committee appointed to enquire into the most suitable scheme for controlling and forwarding the interests of the coffee industry. Developments will be awaited with keen interest. The question of publicity was also discussed at a meeting of the Coffee Planters' Union and the Director of Agriculture stated that on the recommendation of the Kenya Advisory Committee the greatest benefit would be derived from the display and demonstration of roasting of Kenya coffee, and from the distribution of samples at this year's international exhibition at Antwerp. He suggested that two or three tons of coffee would meet the requirements of the exhibition and following upon this statement several members signified their willingness to give bags of coffee for exhibition purposes. The membership of the Kenya Coffee Planters' Union is now in the neighbourhood of 300.

Ivory Coast.

The *Bulletin des Matières Grasses* Nos. 3-4, 1929. (Institut Colonial, Marseilles) contains a paper embodying the results of three years' trials with cover crops at the Government Agricultural Station at La Mé, Ivory Coast. The principal conclusion reached was that such crops were absolutely necessary in the Ivory Coast, for oil-palm, coffee and cocoa. The chief difficulty—that of seed-supply—could best be met by forethought in setting aside a sufficient area to provide the seed required. Particulars of the trade in Senegal ground-nuts show the steps that are being taken to attract produce to Dakar, which is at present the third port of the Colony, the figures being; Kaolack, 122,860 tons; Rufisque, 109,279; and Dakar, 74,002. Another note on ground-nuts shows that in the first 10 months of last year Holland took 69,041 tons, of which 34,263 came from India, 7,799 from China, 5,703 from British West Africa, and the remainder from Spain, East Africa, and the East Indies.—(*West Africa*, Vol. XIII, No. 648.)

* * *

Nigeria.

The following figures published in the 1928 Colonial Report (No. 1435) for Nigeria show that both production and exports have been at a high level during the year under review :—

	Tons.		*Value in £.*
	1927.	**1928.**	**1928.**
Palm oil ..	113,240	127,110	3,816,658
Palm kernels ..	257,206	246,537	4,562,105
Ground-nuts ..	90,773	103,162	1,650,134
Cocoa	39,210 *cwts.*	49,209 *cwts.*	2,309,931
Cotton ..	99,546	74,957	379,490

The increase in the quantities of palm oil, cocoa and ground-nuts exported was quite substantial, and indicates general stability in trade. The decrease in palm kernels is not a serious one and will no doubt adjust itself before long, but the exports of cotton lint showed a further decrease the reasons for which are that planting in the northern areas was greatly reduced in 1927 to enable the food shortage to be recovered, while in southern areas the reduction was the result of very low prices paid in 1926-27. In addition, the latter crop was affected by exceptionally dry weather, but considerable improvement is anticipated in both parts in the 1928 crop as in the current season 1927-1928 the area planted in the "old" cotton-planting districts has been much greater than in the last 2 years—perhaps as great as it has ever been—but the yield per acre in these old districts seems to be rather below normal. There has been a great extension of planting in the Sokoto Province, and there the climatic conditions seem to have been rather more favourable.

The prices of Nigeria's export products on which the prosperity of the country depends have remained very steadily at about the same level as in the latter part of 1927, with the sole exception of cocoa of which the price was more than £10 below that of last year.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Saving Money in the Boiler Room.

Considerable attention has been given in the sugar industry of late to the matter of fuel costs in the steam raising plant. It is well known that several thousands of pounds per annum are spent in buying excess fuel to supplement the megass, and it is natural to assume that if this fuel bill can be reduced the industry will benefit appreciably.

Quite recently careful consideration has been given to this subject, and the problem attacked along the same lines as those on which any business concern is run. It is universally accepted that to attempt to run a business organisation without a system of accountancy would be suicidal. No business concern can function properly unless its directors know at all times exactly whether profits are being made or not. The same system can be applied to steam-raising units, by the use of suitable instruments to determine whether the fuel fed into the furnace is functioning properly, and how much steam is being got out of the plant as a return for the fuel fed into it.

Quite recently some tests extending over a week were made in one of the sugar mills in Queensland, these tests being made possible by the installation of Cochrane Steam Flow Meters and by the assistance of Hays Flue Gas Analyzers and Draft Gauges; also the Hays CO_2 Recorder. As the result of this one week's observation, the engineers of the mill were able to reduce their fuel bill by 25 per cent.; and it is therefore obvious that serious consideration to such a method of intelligently handling the steam requirements of a sugar mill are imperative.

The Cochrane Flow Meter is an extremely rugged and accurate means of determining within half of 1 per cent. the quantity of steam flowing along any pipe. It can also determine the quantity of feed water going into the boiler. With the aid of the information which this meter sets out on the continuous chart, and a knowledge of the process being carried out, very little intelligence is required to determine where the steam can be saved, or where the load factor can be flattened out. Also where the losses take place and the extent of radiation and other leakages. The information is just as vital as knowing the amount of sugar-cane which goes into the mill and the amount of sugar which comes out of it, and there should be no need to elaborate on this comparison.

Of equal importance also is the question whether the fuel which is put into the boilers is being burnt properly. This is often determined by means of a CO_2 analysis, but it is now recognised that a CO_2 analysis, without information as to the furnace temperatures and the draft in the furnace flue does not permit of proper handling of the boilers. It is, of course, understood that a good deal of the fuel fed into the boiler can go up the chimney stack without doing any good. Hays Combustion Instruments are intended to supply this necessary and vital information, and it can be realised without any difficulty that if we know that the furnace conditions are maintained in the most suitable manner for the proper combustion of fuel; and if we know the amount of water going into the boiler or the steam coming out of it, and also where this steam is being used, and how it is being used, savings in the fuel bill which hitherto have been considered fantastic may become an everyday occurrence. —(*Australian Sugar Journal*, Vol. XXI, No. 5, p. 321.)

* * *

Filter-press Cloths.

Dr. K. Sandera, * of the Sugar Experiment Station, Prague, has been investigating in the laboratory the various possible harmful effects on the durability of filter-cloths, his object in view being if possible to elaborate a specification based on physical and chemical tests that would be of value in estimating the quality of various material. For example, breaking tests of new and used cloths of cotton, linen and jute, and mixtures of these, were examined, as were also tests in which the layers of fabrics were compressed under conditions as closely as could be duplicated of filter-press work. High pressure on a layer of cloth, as occurs when the frames of the press are tightened up diminishes greatly its strength, as shown by the breaking strain test. An especially harmful influence is the presence of irregularities on the surface of metal on contact with the layer of cloth, as may be caused by grit. Under such tests cotton and linen behave better than jute. Rust forming on the surface of the cloth very greatly deteriorates its strength. In dressing or undressing a press, the frames may be knocked quite violently together so as to strike that part of the cloth which is pressed together in the frames. A hammering test devised to imitate this condition showed the strength of the cloth to be diminished thus. Here again cotton is the most resistant fabric. In another series of experiments, different cloths were artificially incrusted, and the effect of this on the rate of filtration was determined. Little difference occurred in the case of distilled water, but in the case of molasses solution the rate was distinctly impeded by the incrustation. Cotton and linen here again behaved better than jute. This work on determining the durability of cloth for filter-press work is admittedly incomplete. Other possible factors have yet to be examined in order to discover the reason why some factories in Czecho-Slovakia change once in 3 days and others only every 30 days.—(*I.J.S.* Vol. XXXI, No. 370.)

* *Zeitsch. Zukerind. Czecho-Slov.*, 1929, 53, No. 46, 569-576.

AGRICULTURE IN SURINAME.

FIG. 8.—*The establishment of oil palms with cover crops at the savannah experiment station, Zandrevej.*

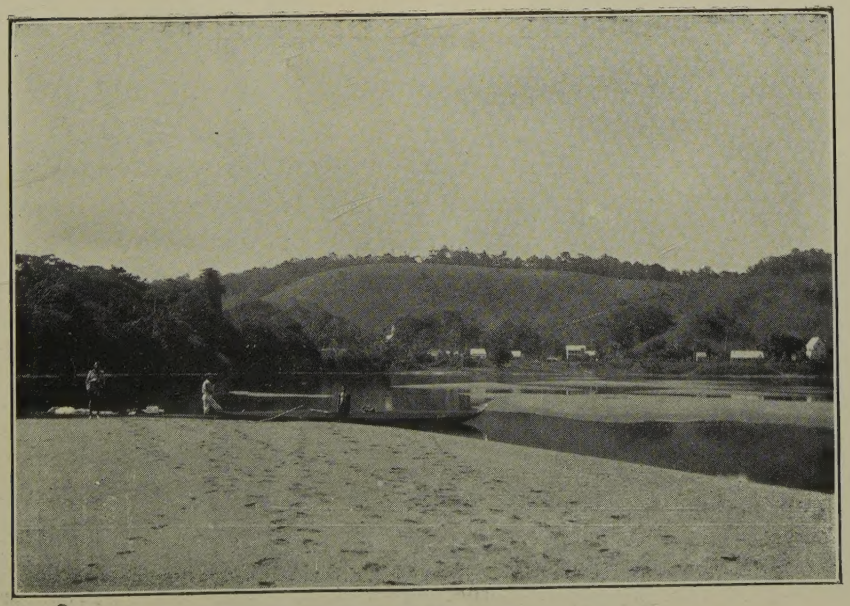


FIG. 9.—*Berg en Dal, on the Suriname River. Rolling country characteristic of the interior of the colony.*

AGRICULTURE IN SURINAME.

FIG. 10.—*Establishment of oil palms on the lateritic soils of the hilly interior.*

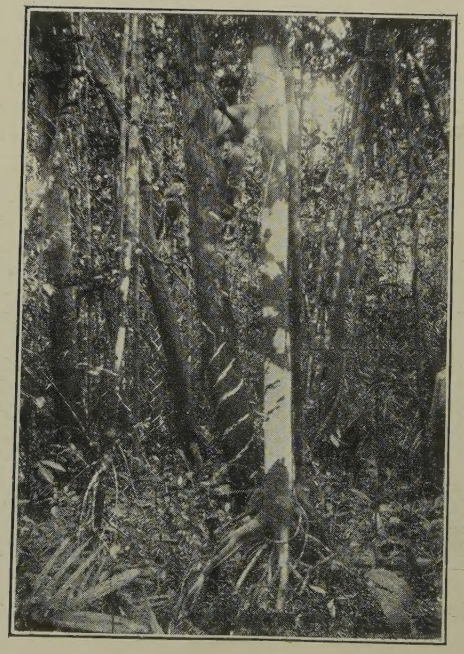


FIG. 11.—*Balata bleeding in the interior.*

AGRICULTURE IN SURINAME.

FIG. 12.—*Reaping cassava.*

FIG. 13.—*A Javanese labourer.*

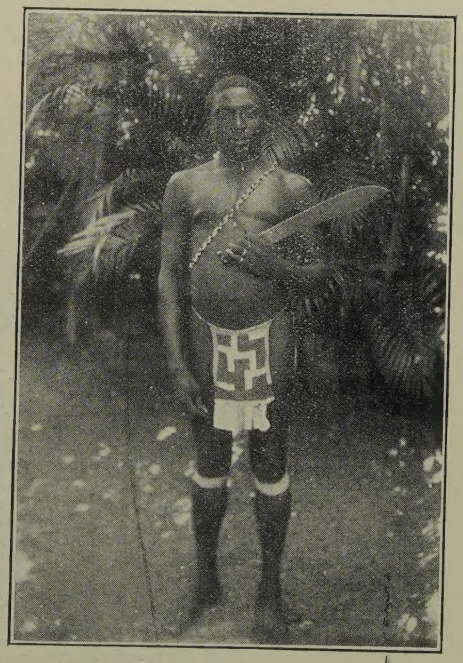
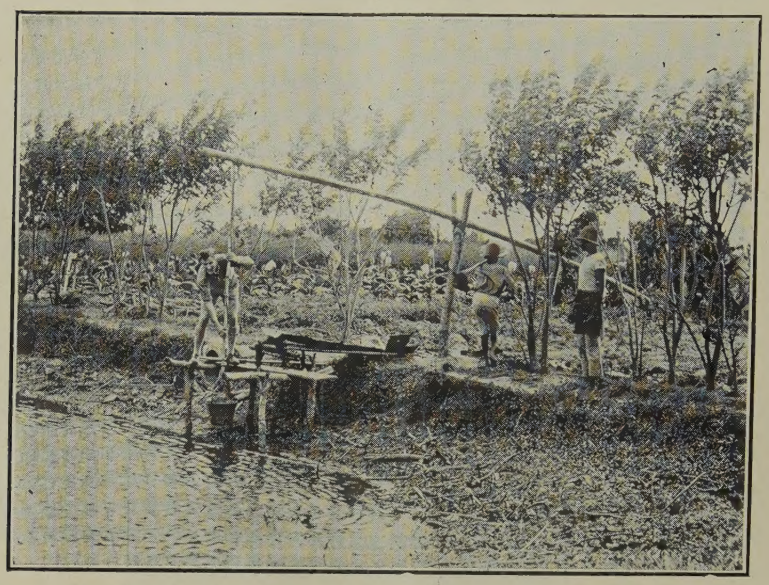


FIG. 14.—*Bush negro.*

A SIMPLE IRRIGATION DEVICE.

(*See page* 37.)



Arrangement of waterlift.

Watering a tobacco bed.